THE

JEWELER'S HAND-BOOK,

CONTAINING

THIRTY PRACTICAL METHODS

FOR

Galvanizing, Electro Plating and Coloring

WITH

GOLD, SILVER, AND COPPER,

On all kinds of Metals,

WITHOUT ANY APPARATUS, AND BY MEANS OF SINGLE AND COMBINED ELEMENTS OR BATTERIES,

WITH AN EXTRA CHAPTER SHOWING THE RECOVERY OF THE GOLD AND SILVER.

Practically demonstrated and embellished with Six Engravings.

BY PROF. RUDOLPH HERR,

OF ALBANY.

WITH AN APPENDING REGISTER OF

BUSINESS CARDS

OF THE BEST AND MOST RECOMMENDABLE

WHOLESALE AND MANUFACTURING FIRMS

Of Watches, Jewelry, Clocks, Silver and Plated Wares, &c.

ALBANY:

J. MUNSELL, 78 STATE STREET.

1855.

TO THE PUBLIC.

By presenting this little book to the public we purported to publish the result of our practical observations and experiments for the benefit of the public in general and the trade. We do not claim the privilege of having discovered the origin of the Electro-Galvanic power, but beg to state that we have since its first notice, 1840, closely followed its progress by experimenting most of the proposed methods, to assume the responsibility of an opinion as to their particular value in a practical point of view.

Simultaneous with the accounts of the first experiments of the theory of making the galvanic agent a conveyance of transporting dissolved metals, we befriended us with the idea of what incalculable importance a practical method, fully competent to meet all demands of the market, would prove; especially as

we always cherished the hope that, sooner or later, a process would be discovered to substitute the old school practice of Fire Gilding.

Previous to the discovery of the wonders produced by the Voltaic Column, the trade was possessed of certain mediums to effect gilding by boiling metallic articles in gold containing chemical combinations, but as those manipulations did not satisfy the critical taste of the public, consequently, the trade had to fall back upon the old practice, which was based on no science, but on mere mechanical tricks, the property of some expert practitioners, who by this means monopolized a profession supported by insignificant secrets.

As, in the course of time, several publications relative to the progress of the Electro-Galvanic experiments attracted the attention of eminent philosophers, remarkable new phenomena were added to the original, all of which conclusively led to the belief, that science combined with energy, would soon find an instrument adequate to the theory, to produce with certainty, by following strict rules, an efficient result. As a matter of course, every experiment showed a different apparatus, and every operation different proceedings, to obtain the desired result. We have therefore spared

neither time nor money, and subjected those methods standing best recommended to the closest examination, a synopsis of which will be found in the different parts of this book, and have occasionally pointed out certain operations, which we thought proper to patronize, but in all cases have only favored such as will come handy to the practical mechanic.

Many were the complaints made to us by persons connected with the profession of Galvanic plating, that their operations *varied so much*, that *no uniform* work was to be obtained, and some (probably entirely disappointed) went so far as to call the *greatest discovery of the age*, a consummate humbug.

To the former we would say, that they will attain their purpose, if they will but adhere to the strict laws of Galvanism, as laid down in the course of this book; and to those, who so indiscriminately condemned a theory recognized by the whole world, we should intimate, that, if some attention was paid to the details of our experiments and a new and fair trial afterwards granted to their apparatus, we warrant a change of opinion.

We are not enough of an egotist as to pretend to be the only individual fully acquainted with the prin-

ciples of Galvanism, as all our knowledge is derived from hundreds of experiments, until we arrived at a point to form a decided opinion, which we took leave to promulgate before the public in this limited number of pages.

We say once more, if your results should not prove equal with our accounts, do not despair of final success, as the causes of your disappointment are often trifling, which, by an *attentive* perusal of these pages, can be *detected* and *removed*.

We conclude our introduction by wishing, that the reader might consider this pamphlet a guide to his operations, as then the aim of our fondest hope is realized, and the highest testimony allowed to our feeble efforts.

Placing our readiness to answer all inquiries in reference to further information, at the disposal of the reader, we respectfully commit these pages to the kind judgment of the public.

THE AUTHOR.

Albany, March, 1855.

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PART IV.

JEWELER'S HAND-BOOK.

PART I.

To deposit Gold, Silver, or Copper, upon any metallic Surface, under the co-operation of galvanic Elements.

CHAPTER I.

Under this head we intend to treat upon the three following methods:

1st. To gild by the single constant chain.

2d. To gild by contact, and without any apparatus.

3d. To gild by means of combined elements, or with so called Batteries.

It will be unnecessary to tire our reader with a voluminous theory of the origin or substance of the above named agents, serviceable to obtain a good golden surface, as those acquainted with physics already know sufficiently their several constructions, and those desirous of becoming acquainted with this important discovery will find satisfactory explanation when we treat of the synopsis of these three methods.

The merit of the discovery is due to Prof. De La Rive, of Geneva (Switzerland), who rendered the first account of his practical experiments in 1840, and as his endeavors were chiefly devoted to method No. 1, we shall not hesitate any longer to subject the result of his labors to our present definition.

He used some animal bladder for the purpose which was filled with a solution of gold in aqua regia (aqua regia is a combination of one part nitric acid and two parts muriatic acid), very much thinned with rain or distilled water.

This bladder was suspended into a glass jar of sufficient capacity to hold it, and this jar contained water acidulated with five or six drops of sulphuric acid.

In this water a circular plate of bright zinc, to which a silver or platina wire is fastened sufficiently long to reach into the solution contained in the bladder, was deposited, and with this wire the article to be gilded was most intimately connected.

By this manipulation the article fastened to the wire acts as the negative pole, and the zinc in the acidulated water is the positive pole, and both poles united by the wire form an element and consequently create electric activity and this electric life is termed Galvanism.

Although this element or single chain produces a very weak galvanic current, it effects a deposition of a sufficient quantity of gold upon the metallic article fixed to the wire.

The stream dismembering the dissolved gold of its connection with the acids and deposits it upon the object at the upper end of the wire, meanwhile the zinc decomposes the liquid matter in the jar. A matter of the highest importance in every respect, is a most scrupulous cleanliness of the article to be gilded.

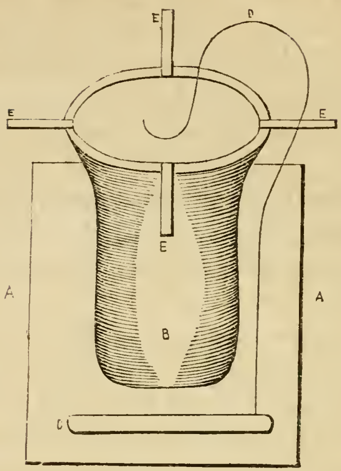
The same must be free of all dust and oxid, and be cleaned to this end with some sour water (mixed with cream of tartar) as the success of the operation is entirely dependent upon the clean and bright surface of the article.

It was then brought into contact with the gold solution for about two minutes and at the end of that time it appeared covered with gold. It was then taken out and dried with some fine linen rags, and this operation repeated until the golden layer was of sufficient strength.

The gold thrown down by this galvanic agent was of a very soft description, and showed a very high yellow color, almost too rich, as for durability, it was fully qualified to stand finishing, but to amend the color the ordinary expedients could not be used, as the different layers of the gold did not adhere firm enough and could consequently not bear the test of jewelers' colors.

By this means silver and brass could be gilded; other metals require a different preparation. The following is an outline of such an element:

No. 1.



A The jar.
B The bladder.
C The zinc.
D The wire.
E 4 pieces of wood fixed to the hoop to hold the bladder upon the border of the jar.

Mr. De La Rive found it to be a great promotion towards creating electricity, if the zinc was amalgamated with quicksilver, which can be effected by rinsing the zinc in a solution of thirty parts of water and one part of sulphuric acid, and then brush it with quicksilver. All other metals, such as zinc, tin, German silver, iron, steel, and bronze, must be covered with copper, before any gold can be deposited.

We have framed another chapter for the preparation and use of copper solutions, and refer the reader's patience to that part of this book.

If we rest one moment to examine the history of Mr. De La Rive's discovery, we are astonished at the rapid and successful progress of the experiments of others who undertook to explore this invention for the benefit of commerce and science.

Messrs. Elkington and De Ruolz, deserve due mention, as we owe to their exertions several new and most interesting features relative to electro-galvanic experiments.

The aforenamed gentlemen attracted by Prof. De La Rive's publication of his "*notice sur un procédé electro-chimique ayant pour objét de dorer l'argent et le laiton*," have added such perfections to the original idea, as to make it a safe instrument in the hands of every mechanic, and practically to substitute the ancient manner of fire-gilding (gold dissolved in quicksilver).

The scientific treatises of Messrs. Elkington and De Ruolz show a connection of cyanide of potassium (fusse and granulated) to absorb the gold in aqua regia, a most useful stimulus to effect a stronger deposition. It can not be denied that by the addition of this chemical and poisonous salt, an advantage of the greatest consequence has been gained, as we shall take occasion to define in the proper chapter.

But on the other hand a great many obstacles have come to light until the actual proportion of the cyanide was ascertained. It is a matter of every day occurrence that a gilded article will be found covered

with a brown surface, or spots, and therefore we have made the object of this book a preventive against all difficulties, by introducing proper rules of proceeding.

We shall now abstain from reciting any more of the history of experiments of eminent chemists and give to our readers a practical prescription for a good gold solution, with the appaiatus necessary to transport its contents.

Two dwts. of gold at least *twenty-two carats* fine, rolled out as thin as possible and cut or torn in very small pieces.

This gold must be collected in some strong fire proof porcelain vessel containing one and a half ounces of aqua regia (nitric and muriatic acids), and evaporate the contents over a spirit lamp guarding against any over boiling.

As soon as all free acids have evaporated and nothing of the liquor is left but the gold chloride, a solution of cyanide of potassium (three-fourths of an ounce cyanide dissolved in half a pint rain water) will be added and the whole of the mixture poured into a glass vessel where it shall be kept.

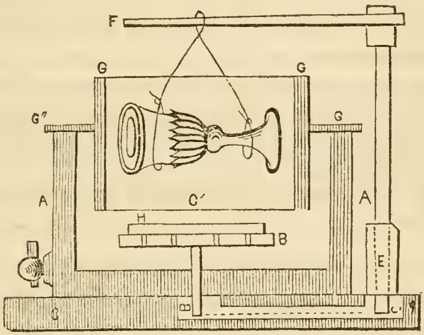
It would be advisable at such operations to avoid the vapor of particularly the cyanide as the effects of it operate very injuriously upon the brains.

The so prepared solution does not require any further handling and is fully ready for usc.

We are now about to describe an apparatus best suited as a single element (constant chain) to deposit dissolved metals upon other metals.

We tried most of the known single constant chains, but none afforded more convenience than the one we are about to delineate, and to facilitate its construction we give a correct drawing in addition.

No. 2.



A A A square box of oak wood well varnished, the size of which must be according to the articles to be operated upon. At the bottom of the same will be seen a copper bar (B), which must be fastened water tight, and ascends two inches inside the box, leaving a tail of half inch to communicate with the channel, D. This bar bears, inside of the box, a grate of copper sheet or copper wire, upon which a cast zinc plate (H) rests. This box is fixed to a strong board (C), in which the channel (D) is perceptible—and this channel connects with a small cavity (C′) on the other end. This channel is filled with quicksilver, through which a thin copper wire, marked with little points, is laid to effect an intimate connection between B and E, strong copper staffs.

From the cavity (C′) the staff E arises, bearing a horizontal and moveable arm (F), likewise of copper, to which

the articles to be galvanized are suspended by means of platina or strongly gilt copper wire.

G A smaller box, destined to receive the gold solution, is made of oak wood, the size of which is made proportionate with the exterior box, leaving a space of one and a half inches, to avoid contact with the outer apparatus. The bottom of this box is hermetically closed by a bottom of bladder or parchment, G′. Four wooden arms (G″) support the inner box, which must be kept at a distance of at least one inch from the zinc plate (H), and could be still further distanced by pushing small blocks under the supporters. The bladder or parchment can always be kept in good shape, by drawing strings across the bottom (G′), forming little squares.

I Is a spout to let out the liquid from box A, when the work is done.

Our readers will perceive that articles of very large size could be gilded by this apparatus, and the same always be kept in good working order when box A is promptly emptied and occasionally revarnished and in case the bottom G′ should get a hole by accident, a small piece of bladder when moist pressed upon the hole will repair the damage, but such repair will never be required if said bottom is cleaned with clear water after use, and then dried in a not over warm room.

It will be of moment to select the bars of tolerable strength particularly E and B as it will be a preventive against any obstruction of the galvanic current.

The ends of E and B must be well amalgamated where they communicate with the quicksilver, as well as the wire in the channel D.

The size of the zinc plate ought to correspond with the object to be galvanized and must be likewise amalgamated. Having described the apparatus and the solution we shall now describe the actual process of gilding.

If the channel is filled with quicksilver, the plate of zinc is deposited upon the grate, the box G is filled with a solution of salt water(one gallon water one-half pound salt): then the smaller box containing the gold solution is suspended into the larger one, so that the solution of gold inside forms a level with the salt water outside, to prevent any hydrostatic pressure. The object is then surrounded with platina or gilt copper wire and suspended to arm F in a horizontal position avoiding contact with the sides of the box.

The article remains one or two minutes in the apparatus and is then taken out, when it will show a slight coating of gold: it must then be cleaned with rain water and cream of tartar and the same operation be repeated until the color of the gold satisfies the operator.

Every additional operation effects a new layer, and of course an addition in weight and by this means one will be able to exhaust the solution "ad libitum." Every article so gilded stands the strongest of jeweler's color and the hardest process of polishing. We had occasion to observe the validity of this process in factories where buttons and plates after being gilded by this apparatus were pressed into various shapes

without sustaining any injury as regards their golden appearance. Round objects such as goblets must be turned several times, as the side nearest to the zinc plate generally takes most of the gold.

When left long in the solution things will appear brown, but cream of tartar readily cleans them and polishing will remove the remainder of this brown surface. As the gilding is effected by a liquid it penetrates and deposits its metals in places which could not be gilded by the process of fire plating.

The practical value of the method will be made apparent as every object gilded by this element when polished is ready for the market and no coloring or gilt waxing is wanted. The gold is so strong as to stand the test of the strong French color, composed of alum, saltpetre and cooking salt, without injury.

If it is desired that only certain parts should take the gold, for instance, the inside of a goblet or cup, the rest of it must be covered with an indissoluble substance a prescription of which we have here annexed.

Five pounds of common brown amber must be warmed over a slow charcoal fire until it becomes so soft as to tear in threads, and then add one pound of linseed varnish, and stir it well with a piece of iron and when boiling take it from the fire and pour five pounds of turpentine to it and filter while hot. To remove the coating of this varnish use a mixture of alcohol and turpentine which restores the former color and brightness.

There is yet a different way remaining to gild or silver the inside of goblets, &c., without covering the outside with the aforesaid composition.

A piece of bladder is taken which contains a piece of zinc connected with a well nealed copper wire, sufficiently long to wind around the goblet.

The inside of the goblet is filled with gold solution and the nealed copper wire which bears at the other end the lump of zinc, is now wound around the goblet and the bladder filled with salt water encloses the zinc and is then hermetically closed and suspended over the goblet so as to reach into the hollow of the goblet.

A contact between the bladder and the gold solution will promote the current, and if the solution of gold has been warmed to forty degrees Cel. previous the process will be performed in much less time and the color of the gold heightened.

As soon as found sufficiently covered, the goblet is washed in rain water made sour with some cream of tartar, and is ready to be polished. This method of gilding by a single element (constant chain) meets all demands of the trade as for durability, beauty, and cheapness, although at the same time we do not mean to impart the idea that these elements entirely substitute the use of batteries. An additional advantage is gained by the use of certain batteries (combined elements), as the solution is always kept at the same scale of concentration and does not require a repreparation, as we shall show when arrived at that head.

Solutions used for single elements exhaust themselves by long or frequent use and fresh gold chloride must be added to keep the solution concentrated. The fresh chloride requires only one-fourth the cyanide used at first, as the average of cyanide already contained in the solution reanimated by the addition is capable of absorbing the chloride and transferring it to the negative pole. But to make sure of the necessary quantity it would be advisable to dissolve one-half ounce cyanide of potassium in one-half pint of rain water and add as much of this solution as will dissolve all the matter which has settled at the bottom, after which the solution will become quite clear, showing a light yellow color.

It must unquestionably be admitted that the electro gilding has every advantage over the old practice of fire gilding, as the latter process consumes more material, more time, and in some instances could not be performed at all, while the liquid gold solution enters the finest cavities, and deposits its contents there as well as on the most even surface. It will be welcome to learn the pecuniary advantage of these two operations:

One dozen watch cases can be fire plated in two days by a good hand, while they can be galvanized equally as well in one hour.

It will take 2 dwts. of fine gold, worth	$2·50
Quicksilver, gilding wax, &c., ...	50
	$3·00

A solution of cyanide of gold will gild twelve watch cases, holding twenty grains of gold, at an expense of $1·10, showing thus a saving of $1·90 on one dozen cases. Supposing the fire plater to receive $2 (10 hours labor) per day, the cost for gold and labor will be $7—and if galvanized, we calculate for the same work, $1·30. We think that economy like this should greatly reduce the old practice, and to our rejoicing we would state, that the greatest factories in this country, and in Europe, have adopted the galvanic agent in place of the ancient fire plating.

It is likewise due to say, that a fire plated article will stand five years moderate wear, while the galvanic plate will last but half the time, but the cheapness attending it will admit of its being plated over three times, and still being the cheapest yet. Before we close this chapter and proceed to silvering with the single element, we take leave to state that we gilded a piece of copper sheet of tolerably strong make and worked the same into a small cup, and after polishing it well we filled it with aqua fortis and *boiled it upwards of fifteen minutes without injury to the cup.*

CHAPTER II.

To Silver with the single constant Chain.

As the apparatus used for silvering is exactly the same as we described in chapter first, page 15, we shall not lose a moment to acquaint our readers with the preparations of the several solutions answering the purpose.

One half ounce of silver coin is dissolved in one half ounce of chemical pure nitric acid, and when dissolved thin it with one half pint of rain water, and then one fourth ounce table salt, or one half ounce muriatic acid, added to the whole, will precipitate the silver to the bottom of the vessel in the shape of a snow white substance. This substance (silver chloride) is dissolved by a solution of three ounces of cyanide of potassium (granulated), in one quart rain water, the chloride of silver having been washed previously to free it of the nitric acid, and then another solution containing two ounces of sal ammoniac is poured into it, and the whole must now be boiled for at least one hour, refilling the evaporated water, and then being filtered must show a bright yellow color, and is then ready for use.

As many practical men will find it difficult to handle so many materials in order to obtain a good solution, we have found another composition in preference to the above, as any kind of silver will answer, no boiling being necessary, the addition of spirit of ammoniæ to be dispensed with and the whole being just as good as desired.

One ounce of alloyed silver to be dissolved in a sufficient quantity of nitric acid; when dissolved one half pint of rain water is added; we then pour in muriatic acid as long as any boiling is perceptible; we then pour off the liquid, and rinse it in clear rain water till all the bluish tint is vanished, and the white substance settled at the bottom; we then add a solution of three ounces cyanide until the whole of the substance is dissolved, making a light yellow mixture, and is ready for use.

As a general rule, silvering is effected easier and in much less time than any other galvanic process, and half of the electric power is required to throw silver on a metallic article, and never will it be necessary to warm the solution, as the ordinary temperature is sufficient.

To effect frosted silvering, the article must remain about one quarter of an hour in the solution, then be dipped into boiling rain water and be dried in the air. If, on the other hand, it would be desirable to have it bright, brushing or rubbing with cream of tartar will produce it.

It will be of the utmost importance to clean articles most scrupulously, and handle them always with wet fingers, as a great many spots will arise from handling them uncarefully. The silver deposited adheres tight, and can not be worked through by polishing, hammering or stretching.

It might happen that a fresh solution would produce a grey instead of a white silver, or perhaps it might blacken the article, but the operator must not despair of success; then, in the first case, cleaning with cream of tartar or white sand will suffice to remove the deposit, and in the last case a lump of soda precipitated into the solution will annihilate the iron connected with the cyanide, and the fresh and well cleaned article will show a good white silver color when taken out a second time.

Although silvering is a very easy and quick manipulation, still certain rules must be observed to make sure of a good result. German silver goods must be suspended with lead wire, as otherwise however strong the silver coat may be, it will peel away and not stand finishing. Steel, iron and bronze must be coppered first and suspended with platina wires.

Steel spectacles must lose their blue coat as no silver would remain otherwise. The same rule must be observed with regard to steel pens if blue, and when brown they must be washed with nitric acid in thirty parts of water; in the former case a mixture of one

part sulphuric acid, thirty parts water, will remove the blue outside and restore the original color.

As the apparatus described and illustrated as No. 2 is fully qualified to transport and deposit gold, silver and copper, we refer the reader to those pages relative to the use of the single element (constant chain), and proceed now to acquaint our friends with the necessary information to prepare a good copper solution.

CHAPTER III.

To deposit Copper by means of the Single Element (CONSTANT CHAIN).

The main object of applying a copper surface to other metals is to protect them against the injurious influences of a moist atmosphere.

It was proposed in the Mechanics' Magazine, vol. 31, page 162, to cover steel, iron, brass, &c., after they are well cleaned, by the so called salt of copper, which material is too well known to admit of a new analysis. This dissolved salt of copper was applied by means of a brush and dried over charcoal heat and looked more like oxided iron than copper. Another proposition, to use a mixture of blue vitriol and verdigris, was of no better result. In both cases the coating was *not* proof against oxid.

Before we detail our prescriptions, we deem it of moment to inform our readers that cast iron goods, if very much covered with rust, must be freed from this oxid by the following chemical composition:

Ninety-eight parts of muriatic acid and water 45° *Bé* and two parts vitriol of copper, in which they must remain until all rust is removed.

One ounce copper dissolved in sufficient aqua regia until all acids have evaporated and then cleared with eight ounces cyanide, in one quart rain water, until all blue color is gone, and the appearance is like clear water.

Another less complicated preparation will be the following solution:

One half ounce of blue vitriol crushed very fine and dissolved in one pint hot rain water and the blue liquor dismembered by a solution of one and a half ounces cyanide dissolved in eight ounces rainwater.

Apparatus No. 2 will serve as an agent to deposit this copper, but the solution must be warmed to thirty deg. Cel., and will generally take six times longer than the operation of gilding or silvering.

PART II.

To Gild by Contact and without any APPARATUS.

CHAPTER I.

Monsieur de Frankenstein, in his lectures, claims the merit of having first and successfully suggested the idea of producing an electro galvanic action by simply bringing into contact two metals in a comparatively neutral solution, and without the influence of animating or exciting acidulated liquids, and even without the otherwise indispensable union of the two poles. As the experiments of M. de F. must be reported satisfactory, we shall not tarry to illustrate the proceedings.

One dwt. of gold dissolved in aqua regia; (here equal parts of nitric and muriatic acids); evaporate all acids and dissolve in a separate vessel one fourth ounce of cyanide of potassium, (fusse), one eighth ounce of corbonate of Kali one fourth ounce of cooking salt, altogether dissolved in one quart of water; then the gold chloride is added. This mixture must then be boiled, and filtered afterwards.

This solution, although very complicated, will produce the wished for result, but as the ingredients of

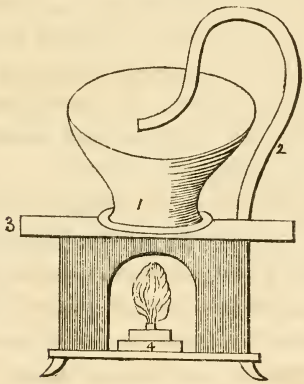
this composition are too numerous and rather costly, we have to recommend the following method, which will be found equally as efficient.

One dwt. of gold chloride dissolved in one quart of water already containing three fourths of an ounce of cyanide, three fourths of an ounce cooking salt, one half ounce chrystalized soda.

The prevailing yellow color will soon disappear and the mixture become as clear as spring water.

The following is an illustration of the apparatus:

No. 3.



1. A porcelain vessel containing the solution.
2. A strip of zinc.
3. A plate of zinc holding No. 2.
4. A spirit lamp.

The article to be gilded is clasped to the end of the strip No. 2, which reaches into the vessel: the article

must be sufficiently covered with the solution and the end of the zinc strip, which holds the article to be gilded, must be well scraped so as to appear as bright as possible, and by this means the gilding will be done in two or three minutes. Another still simpler manipulation will be the following, purporting the same result:

A fireproof, earthen or china vessel, containing one of the above mentioned solutions, heated to forty deg. Cel, the article to be gilded is heated to the solution, and touched with a bright piece of zinc will immediately show a golden coat.

All metals (German silver and steel excepted) will receive a beautiful color, but these two metals will have to undergo a washing in a mixture of one part of nitric acid and thirty parts water (clear), and then they will be fully ready for gilding.

We headed this chapter by saying, gilding without any apparatus: to prevent misconstruction, we would beg leave to state that no work can be done without tools, and that a strip of zinc is not exactly an apparatus but a mere tool, and as the practice excludes the use of single and combined elements or any other galvanic apparatus, we thought ourselves justified by calling the operation gilding without any apparatus; but for the sake of verifying our assertion, we shall treat our reader to a manner of gilding where not even zinc is requisite. But this process, although it has its merits, would hardly be commendable, as the pre-

paration of the solution is too costly and the gilding stands no handling.

Dissolve one dwt. of fine gold in aqua regia, over a moderate heat, until it becomes purple, then mix the gold salt (chloride) with one part rain water, then add a solution of one half ounce carbonate of kali, until the liquor becomes turbid and then of a greenish color. This solution has to be warmed, and when boiling is ready for use. By this means well cleaned objects of brass, copper, zinc and tin can be nicely gilded if suspended from a bright copper wire for a moment.

Silver and German silver require iron wires.

Steel and iron have first to be coppered.

The kind reader will now conclude that the head of this chapter is no exaggeration, as it finds its verification in the last named process, which does not exhibit the presence of any galvanic current, although we positively deny, when speaking of the illustration No. 3, the presence of a regular galvanic conflux.

CHAPTER II.

To Silver without any Apparatus.

To commence this chapter we would say that it is but just to give M. de Frankenstein's method full credit for the successful issue of this idea when first mentioned.

He dissolved one quarter of an ounce of silver, no matter whether chemically pure, in one-half ounce nitric acid, and transferred this chloride of silver into a solution of one pint water containing one quarter of an ounce cooking salt.

A heavy white looking substance was formed at the bottom when the rest of the liquid was removed. This white substance was washed until it appeared of a snowy whiteness and then two ounces of sal ammoniac were poured over it.

Another solution consisting of one and one-quarter of an ounce cyanide one and one-fourth of crystalized soda one-half ounce of salt and one quart of water was prepared to receive this substance (chloride of silver.) To this mixture the chloride of silver with the sal ammoniac was added and boiled for some minutes and then filtered.

By this solution, wares of German silver, copper,

brass, and bronze can be silvered by merely holding them into the boiling solution

The following is another very useful prescription:

One part chloride of silver mixed with three parts cyanide, adding enough water to make it a thick paste. This mixture is applied by means of some woollen rags and effects a bright silver surface which, however, is not proof against a hard polish.

Although the usefulness of the contact operation can not very well be denied, it is, however, lacking of a general practicability as very large articles could be but imperfectly acted upon Another stimulus of the process of silvering will be the use of a piece of zinc (bright) as by this means a deposition is sooner effected. Another and a very important difficulty arises from the use of the zinc strip as the zinc covers itself, even by very limited use, with cyanide of zinc which has to be removed by continual cleaning as little parts of this cyanide amalgamate with the solution and make filtration requisite as other wise those little flakes impart spots upon the silver surface, and in some cases the cyanide accumulates to a very considerable quantity and interrupts the process of absorbing altogether.

Let all that remain as it is, M. de Frankenstein has the honorable merit of having invented the most simple and most practicable (in some measure) method of decomposing metallic liquids.

CHAPTER III.

To copper by Contact and without any Apparatus.

To produce a copper surface we recommend our solution described on page 27. A bright strip of zinc will answer exactly to effect the deposit of copper which will be proof against the influence of every atmosphere.

A method to the same purpose will be the solution mentioned on page 26 where simply the remaining of the article for the space of fifteen minutes is necessary to produce the desired effect.

As we have no other practical method to refer to, we will conclude this part by proceeding to the most important section of this book.

PART III.

To gild by the cooperation of combined (constant) Chains or Galvanic Batteries.

CHAPTER I.

The definition of the term galvanic battery is the connection of several constant chains (elements) by means of which a more powerful galvanic current is produced; a circumstance simply explained by the fact, that every chain exercises a certain galvanic conflux and if several such chains (elements) properly united among themselves are necessarily qualified to produce so much more galvanic power.

Galvanic power or galvanic electricity are names given to that form of electricity which is produced by chemical action. It is established, that when two metals are placed in contact with each other and with some liquid capable of acting upon one more than upon the other, electricity of a peculiar character is developed. The peculiar electrical relation to the metals employed, also exerts an influence upon this result. The metals most extensively used are zinc and copper, or zinc and platinum; and the chemical agent

is some liquid containing an acid having a powerful affinity for zinc. The language adopted in describing the resulting phenomena was founded originally on the supposition that electricity is given out to the copper from the zinc, which is corroded through the liquid between them. If a glass vessel filled with fluid, would contain a copper and a zinc plate, exposing their respective surfaces without being in contact, the supposed motion of the electric current within the glass would be from the zinc to the copper, and if the two metals are connected by a wire without the vessel, in order to fulfill the condition of metallic contact, the electricity is supposed to pass around through the wires from copper to zinc again, to restore the equilibrum of the fluid. Thus the current is considered as passing from zinc to copper *within* the series and from copper to zinc *without* it. The wire connected with the copper is the positive pole (anode) of the arrangement, and that with the zinc the negative pole (cathode).

The electricity proceeding from the positive pole is the same in its relation as the electricity from the prime conductor of the electrical machine, which originally received the name positive, while that from the negative pole corresponds with the electricity obtained from the rubber of the machine. These terms are, however, to a certain extent, arbitrary. It is still an open question, whether there is one fluid moving in a particular direction, or two fluids moving in oppo-

site directions, or no motion of a fluid at all. The fact which is sought to be explained by these theories remains fixed. For the above described circulation of the electrical current, technically called the galvanic circuit, there is an electrical influence propagated in a certain unchanging direction, and as the control of the magnetic and chemical reactions produced depends upon our knowledge of this, it is necessary that the signification of the terms should be understood.

Professor Farraday has proposed a nomenclature of electricity, which has been adopted in some scientific treatises. The poles are called by him electrodes, from the Greek ἤλεκτρο and ὑδὸς; that is, ways or path of electricity; the positive pole (the anode) Greek, ἄνοδος, an ascending or entering way, and the negative pole the cathode, likewise from the Greek, κάδοδος, a descending way or path of exit. The terms positive and negative pole are, however, still most frequently used to designate these extremities, and the wire without, when in connection with these poles, is spoken of as the channel of a positive current passing from the former to the latter.

Instead of using two metals to form the galvanic circuit, one metal, in different states, may be used on the same principle; the essential condition of this current being only, that one part of a conductor of electricity shall be more corroded by some chemical agent than another part. Thus, if a galvanic pair be made of the same metal, one part of which shall be softer

than another, as of cast and rolled zinc, so as to be differently corroded, or if a greater amount of surface be exposed to corrosion on one side than on the other, or a more powerful chemical agent be used on one side, a current will be determined from the part most corroded through the liquid to the part least corroded, whenever the circuit of the poles is complete.

Galvanic electricity is capable of producing the most extensive magnetic, chemical and calorific effects. In this respect, it has a far greater capacity than mechanical electricity, though it is found that, by the accumulation of this latter, the same effects can be produced in proportion to the amount present. This has led to the natural inference, that, in galvanic electricity, the quantity present is immense, while in mechanical, the quantity is small. On the other hand, it is found that, in the latter form, the electricity is much more energetic in its physical reactions; that it appears to be condensed upon insulated matter, and strives to obtain an equilibrum by diffusion in every direction. It is therefore said, that mechanical electricity has more intensity than galvanic, though it is difficult to assign other than a general idea to this word. Owing to the difference of intensity, the snbstances, such as glass, earthenware, wood, ivory, which act as nonconductors to galvanic electricity, are much more numerous than the corresponding class, with reference to mechanical electricity. A true comparison between these two forms of electricity would be made

between the galvanic current and a current of mechanical electricity freely circulating as through a wire connecting the prime conductor and the rubber of an electrical machine. So compared, the fluid would be found in both identical in its effects, with scarcely greater difference in the conditions of quantity and intensity, than we are able to produce by different arrangements of galvanic series.

There are two methods by which the peculiar powers of a galvanic arrangement may be increased; first, by increasing the size of the plates used; secondly, by increasing their number.

The extension of the size of the plates. If the size of the plates, that is, the extent of the surface acted upon by the chemical agent, is increased, some of the resulting effects become more powerful in the same proportion, while others do not. The power to develop heat and magnetism is increased, while the power to decompose chemical compounds and to affect the animal system is very slightly, or not at all, augmented. Batteries constructed in this manner, of large plates, are sometimes called *calorimotors* from their great power of producing heat; and they usually consist of from one to eight pairs of plates. They are made of various forms. Sometimes the sheets of copper and zinc are coiled in concentric spirals, sometimes placed side by side; and they may be divided into a great number of small plates, provided that all the zinc plates are connected together and all the

copper plates together, and then, finally, that the experiments are performed in a channel of electrical communication opened between the one congeries and the other; for it is immaterial whether one large surface be used, or many small surfaces electrically connected together. The effects of all these arrangements, by which the metallic surface of a single pair is augmented, is to increase the QUANTITY of the electricity produced.

2. *The extension of the number of the plates consecutively;* that is, by connecting the copper plates of each pair with the zinc plate of the next pair. By this arrangement the electricity is obliged to traverse a longer or shorter series of pairs; each pair being separated from the adjoining ones by a stratum of an imperfectly conducting liquid, or by the walls of an insulating cell. The result is, that the electricity acquires that additional impulse, which has already been referred to as intensity. It has greater power to pass through imperfect conductors, or through intervals in the circuit, to give shocks to the animal system and to decompose chemical compounds; and when the number of consecutive pairs of plates is increased to some thousands, or even hundreds, the electricity developed approaches very near in its character to that produced by the electrical machine; it manifests similar attractions and repulsions, and in fact the Leyden jar may be charged with it. With a very extensive series excited by water only, and in

which each cell was carefully insulated, an English electrician has lately obtained an electrical discharge between the poles, although separated to a considerable distance. The electricity from one pair of plates has a very low intensity. As the numbers of consecutive pairs is multiplied, the intensity increases, until at length it approximates to that of frictional electricity, which is able to strike across a considerable interval of air and to fracture solid nonconductors interposed in its circuit.

In consequence of the low intensity of the electricity required for electrive magnetic experiments, it is very easy of insulation. This is a great advantage in regard to the practical construction of magnetic apparatus. Where electricity exists in a state of high intensity, it has a strong tendency to pass off, and dissipate itself through imperfect conductors; but where it exists only in quantity it requires nearly perfect conductors to allow it a passage. The electricity developed by a single pair of plates, however much its power may be increased by adding to the size of the plates, will scarcely pass across the smallest interval of air, and a wire conveying the current may be perfectly insulated by a covering of varnish. In working the electrical machine, on the other hand, the electrified parts of the apparatus must be kept at a distance from each other, raised on glass supports, or suspended by silken lines; and then, unless the atmosphere is very dry, the electricity will be rapidly

dissipated. But in the case of currents of low intensity, however great what is called the quantity may be, two wires may be side by side, with a coating of varnish or wax betwen them and convey different and opposite currents, without any perceptible electrical intercommunication.

Having now sufficiently demonstrated the origin, laws and absolute principles of galvanic electricity, we think the reader is fully informed of the necessary theory to pass over to practical experiments. Although many of the above named phenomena do not directly allude to gilding, silvering, etc., we could, however, not abstain from citing them, as they together with the rest facilitate comprehension.

The first galvanic electric apparatus as detailed by Mons. Dumas in his reports to the Academy of Fine Arts consisted of a Voltaic column including six elements (Leyden jars) of 2 decimetres each.

The electric activity was produced by a solution of vitriol of copper and of salt.

Before we undertake to describe the different kinds of batteries we would like to aim at a clear understanding about constant and inconstant batteries.

By the former we intend to impart the idea of speaking of a galvanic apparatus capable of developing electricity for a term of at least a week or more without any material interuption, and by the latter we mean instruments which exercise a certain degree of electric power for much less time (an hour or so).

It will soon be admitted that a battery of the latter description would not answer to practical use and therefore we deem ourselves justified in passing over them without further mention.

Since the first publications of Dr. Alexander Petzhold, Professor Kaisen and Dr. Alexander (1841), we have strictly followed their course and feel happy to say that their theory was found to be entirely consistent with practice, although many of their methods require simplifying for the practitioner. We have devoted a good deal of time and capital to explore their discoveries and to make them bear towards the interest of the trade, and how far our endeavors were successful will be seen in the course of this chapter. To best enlighten our readers we deem it proper to benefit them by a description of Dr. Petzhold's apparatus.

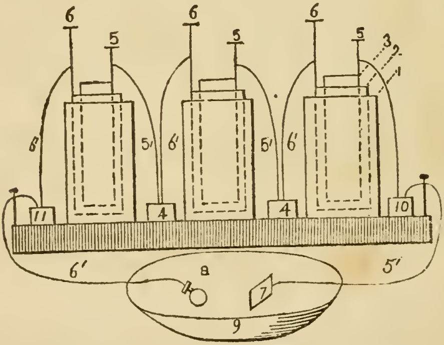
The same consisted of six elements of copper and zinc in the shape of cylinders; the copper cylinders measuring six inches in height and three inches in diameter, and the zinc cylinder six inches in height and four inches in diameter.

The copper cylinders were enveloped in bladder, and then filled with a concentrated solution of vitriol of copper.

After that both cylinders (the zinc cylinders embracing the copper cylinders) were placed in some stone pots of seven inches in height and five and a half inches in diameter in the following order:

First, the zinc cylinder which is open on both ends and in the zinc cylinder the well enveloped copper cylinder, but if the zinc cylinder is placed into the pot, the same must be filled with a strong solution of cooking salt in water. The whole of these six elements (every one of them is a constant chain) were placed upon a level board and united by means of copper wire, the one end soldered to one of the cylinders and the other dipping into a small cup filled with quicksilver. For a better conception we give the following illustration:

No. 4.



1 A stone pot to hold the cylinders and the solution of salt water.

2 Is the zinc cylinder.

3 The enveloped copper cylinder.

4 Little cups containing quicksilver.

5 Prominent staffs on the copper cylinder.

6 Prominent staffs on the zinc cylinder.

5′ Copper wire connected with No. 5.
6′ Copper wire connected with No. 6.
7 A piece of platina tightly fastened to No. 5′.
8 A watch case fastened to No. 6′.
9 A vessel containing the gold solution.
10 A cup of copper.
11 A cup of zinc.
11 A supporter for wire 5′
13 A supporter for wire 6′

The limited space did not permit of showing a full representation of six such chains, but we hope that the figure delineating a series three Leyden jars will enlighten our reader satisfactorily.

The general length of the copper wires between the cylinders was eleven inches, and the copper and zinc staffs could be detached from their respective cylinders, being held by tightly fitting hollow curves.

This battery was working for forty-eight hours when the solutions of vitriol of copper and salt water were exchanged for a fresh solutions. The end wires (coming from the last cups) were of gold when gilding was proposed, of silver when silvering was desired, and of copper when coppering was to be done.

To make sure of the presence and strength of the galvanic current, a circumstance of great importance, a magnetic needle 2″ in length with a compass dial 2″ in diameter is inserted upon one of the copper wires and showing a northerly direction parallel with the wire when no electric current was prevailing and a strong right angular motion as soon as the elements became animated.

The magnetic pointer would gradually come back to its former position as soon as the galvanic stream slackened or ceased.

It is claimed that such a compass was indispensable to show the constancy of the electric power and to ascertain how much gold was decomposed as of course no discharge will take place in the absence of electricity and too much gold might be consumed by too strong conflux, therefore this magnetic needle was considered a scale to calculate the amount of the discharge of the solution.

This kind of battery is no doubt a very powerful one but whether sufficiently practical we shall endeavor to show.

Firstly, the complicated nature of these elements speaks against their adoption.

As a second important reason for our disapprobation we would mention the high price of quicksilver.

A third and final point, is the great waste of time to keep the described apparatus in working order.

Meritorious, however, as the battery is, it requires some reforms, which happily are found and will be defined to our reader's satisfaction, at the same time begging the inventor's pardon, that we undertook to simplify his apparatus and then recommend its adoption for general and practical use.

We shall now take the liberty of describing another apparatus (battery) simple in construction and practical for the profession.

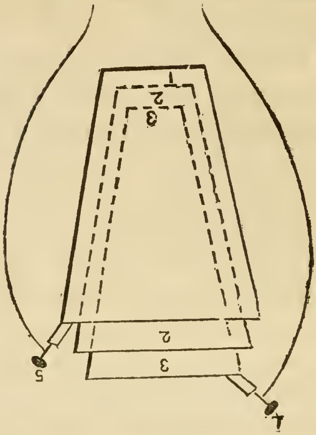
It was invented in the year 1842 by Ferdinand Werner of St. Petersburgh.

He used a tolerably large cup of copper half filled with a solution of blue vitrol. In this copper cup an earthen unglazed cylinder (porous cell,) was placed half filled with a solution of one part sulphuric acid and thirty parts water into which Mr. F. Werner puts a we amalgamated sheet of zinc rolled in cylinderical shape, but good care was taken that these two solutions did not flow into each other; they filled their receptacles within an inch of the brim. The cup as well as the zinc cylinder had a prominent strip or staff to which the connecting wires could be attached, either by winding them around or by means of a screw cup.

This connection is much better than quicksilver, which easily produces spots upon the metallic surface.

The several trials to which we have subjected this battery fully gives us the satisfaction to recommend it to the profession as a safe and good instrument, and for a better understanding we annex the following diagram:

No. 5.



1 The copper cup.
2 The earthen (unglazed) pot (flower pot) (porous cell).
3 The zinc cylinder.
4 Zinc pole cup (negative pole).
5 The copper pole cup (positive pole).

The battery just described is calculated to gild or silver any moderate sized article in a very short time. The gold receives a beautiful color, stands polishing or coloring, and does not wear off so soon, as one dwt. of gold (by means of such a combined chain) will be thrown down in one hour.

It is with particular interest that we patronize this apparatus, as its construction can be effected every where without much expense and its facilities answer the demands of the most critical and economical practitioners. In case the construction of several of these

batteries would appear desirable, they must be connected with clasps always a copper end to a zinc end. Mr. F. Werner has invented some other batteries, of which we make no mention, as this apparatus has all the qualifications of a good battery. The reader will notice that the illustrations No. 4 and No. 5 bear some resemblance, with the exception that the latter has no cups for quicksilver, no stone pots to hold the salt and no bladder to separate the copper cylinder from the liquid in the zinc cylinder, and therefore we take occasion to add, that although Mr. Werner's battery is in a great measure reduced and simplified, it is not inferior to No. 4.

No spots and no brown color will be observed, provided the solution be in good concentration and the apparatus itself clean and filled with a good stimulus; a moderate, constant galvanic current is prevailing and the gold deposited looks uncommonly well and will be found to sustain a great deal of wear, and no warming of the gold solution is required, as the ordinary temperature of the room is sufficient. Having now sufficiently explained the merits of Mr. Werner's battery, we proceed to state that the elements constructed by Messrs. Bunsen, Daniell, Mullin and Smee, are not less recommendable, but we had not leisure enough to try their qualifications to venture any opinion, but can assert that they are extensively used by many manufacturers, which bespeaks their practicability.

As we now come to the most important part of this book, we invite the particular attention of our readers, as we shall give them the result of our experiments with the batteries invented by Mr. Daniell, by the means of which one and the same solution can be used WITHOUT EVER BEING EXHAUSTED.

The important consequence of this incalculable advantage is chiefly manifested, as many ingredients necessary to our solutions cannot every where be obtained, and as the preparation of the solution itself is not sufficiently gratifying to admit of a daily repetition.

A still greater benefit results from this battery, as we are enabled to calculate to the very least part of a grain how much gold we used or in how much time we are able to deposit a certain quantity of gold, silver or copper.

The battery in question we have kept in activity for upwards of eight days without changing or renewing the solution or making any alteration whatever, and therefore we believe ourselves equal to the responsibility of pronouncing it superior to any we have heard of.

The construction is so simple and the materials which are every where to be obtained, allow every workman (even the most economical) to procure it.

We have generally used two glass jars of four inches in diameter and six inches in height, and two sheets of copper and zince rolled in cylindrical shape of the

same height, and two earthern unglazed cylinders (porous cells made of red potter's clay), as a matter of course all of a different diameter, allowing the largest diameter for the two jars, then follow the copper, earthern, and last, the amalgamated zinc cylinders.

The earthern cylinders must be of good texture and have a reddish yellow brown color, then if they impart their color or are very thin, they break easily, and make the process expensive.

If the battery has been put into working operation, two bright copper wires (conductors) tightly fastened to the last brightly cleaned zinc staff of the zinc cylinder on the left and on the last bright cleaned copper staff of the copper cylinder on the right, to guide the electric current into the solution, which must be kept in a small porcelain vessel over a furnace to heat it. To the wire coming from the zinc pole we fasten the article to be gilded, silvered or coppered most intimately, having particularly cleaned the article previously.

The article itself must be entirely covered with the solution, and must not be handled with unclean fingers, and it will be best to work with wet fingers; at least that was the way we have always done, and our work has never shown spots. It would be just as well to use a gold or heavily gilt wire, or when silvering, a silver or silvered one, as the solutions are of a corrosive nature, and partly dissolve the wire (generally speaking): therefore, should a copper wire dissolve in a silver solution, the same will receive a reddish tint

and the pure color of gold might receive a slight change into red, which would prove very disagreeable in some cases. If, therefore, gold or silver wires are not to be obtained or too expensive in the opinion of the reader, we would propose to lengthen them with platina wire as far as they reach into the solution, and although platina wire is also expensive it will save money, as it never dissolves and does not interfere whatever with the color of gold or silver. To ease the operation, it will be necessary to attach a large strip of gold (if gilding, and of silver if silvering is the purpose) to the wire coming from the copper pole end (to the right) which dives into the solution half of its size.

By the means of a thin piece of gold or silver at the end of the positive pole (anode), the respective solutions keeps its concentration as the gold or silver deposited upon the surface is substituted by the gradual dissolution of the anode.

According to the theory the anode (the gold, silver or copper strip attached to the copper pole end wire) commences to dissolve or to absorb as soon as the galvanic battery develops its electric activity, and the decomposition of the anode replaces just as much as the actual solution discharges upon the negative metallic article (kathode). This is the great advantage which makes this battery superior to so many others, as the process of consummation and supply is produced in the same time, and the solution could never be ex-

hausted, as the deposit shows precisely the increase in weight of which the gold or silver strip is minus of its originalweight.

We will not dwell upon the benefits of this process any further, but must state, that with the advantage of preserving our solution we are, at the same time, enabled to give an exact figure for the work done, because we know to the very grain how much material we have consumed and may with safety calculate the job.

We do not wish to impart the idea to the readcr that we have the merit of having discovered the use of gold or silver strip, as it was the idea of the deceased Duke of Leuchtenburg, who devoted a good deal of time and capital to galvanic experiments.

Under his direction the galvano plastic institution of St. Petersburgh felled annually 36,300 pounds of copper, 300 pounds of silver, and about 960 ounces of gold per month, all by galvanic agents. The wires used to hold the anode and kathode, must not be too long or too thin, as in both cases the effects of the galvanic current would be less efficient.

The two glasses are filled with the solution of blue vitriol, the copper, earthern and amalgamated zinc cylinders with the salt water are placed properly into each other and the wires fixed to the poles (copper and zinc staffs); the kathode (the article to be gilded) is fixed to the zinc pole wire and the anode (gold or silver strips) to the copper pole wire, a steady galvanic

current commences and the appearance of small bubbles arising betokens the presence of electricity.

In the course of the operation a brown colored powder accumulates on the gold and a grey powder on the silver stripe, which is dissoluble cyanide of gold or silver, which must be removed either by shaking the wires or by stirring the stripe, as the surplus of cyanide of potassium dissolves this metallic powder.

When the battery has performed its task aud is no longer necessary, we proceed in the following manner:

We detach the screw cups and take the copper and zinc cylinders from their respective solutions, rinse them well in clear water and cleanse them in a manner to be hereafter described.

The salt water has mostly become turbid after standing forty-eight hours and must be poured away, as it is not worth preserving, and the solution of blue vitriol ought to share the same fate if minus of its blue color, as in this case it has lost all its copper, and therefore if we intended a long operation, we refresh it by some chrystals of blue vitriol as soon as we discover the solution to be colorless.

The jars and cylinders are carefully rinsed and set aside; the copper cylinders we wash with a thin solution of muriatic acid and dry them.

More difficulties will be found when we come to the zinc cylinders, as when used for several days a black crust covers the zinc which can not be removed with the hardest brush, and therefore we found another ex-

pedient to effect the cleansing much quicker and in a more perfect manner, a plan which has been adopted by nearly all practitioners to whom we had occasion to communicate this idea.

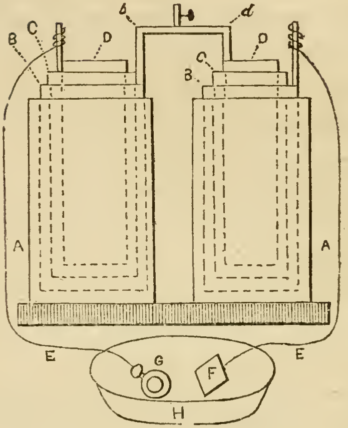
We wind a well nealed copper wire around the zinc cylinder and fasten to the other end a piece of cast iron of the same length as the cylinder.

Both metals, thus prepared, are laid into a solution of one part of sulphuric acid and thirty parts water, and as soon as a rise of bubbles will be seen on the iron (water being decomposed by the galvanic chain of the zinc and iron), this black crust which sticks so tight to the zinc begins to dissolve.

The zinc must be turned several times, and if the development of bubbles should cease it will be necessary to add some sulphuric acid, and it would be well to aid with the brush towards the removal of the crust, and in a very short time the amalgamated surface will be visible and then the cylinder must be washed and dried.

We think we have now sufficiently explained the most important circumstances connected with the use of this battery, and proceed now to illustrate the same:

No. 6.



A A Two glass jars or stone pots.

B B Two copper cylinders made of copper sheet rolled in that shape open on the side, and are provided with a prominent patch or staff on one side.

C C Two earthen but unglazed cylinders made of potter's clay (porous cells).

D D Two amalgamated zinc cylinders.

d The patch or staff of the zinc cylinder D, in the element to the right connected with a screw to copper cylinder. B's patch to the left.

The interior places of the cylinders are marked by interrupted lines.

To the patch or staff of copper cylinder B, to the right wire E, is attached, which holds the gold or silver sheet F, which reaches partly into the solution contained in vessel H and to the patch or staff of the zinc cylinder D, to the left another wire, E, is attached, holding the article G, to be gilded.

The vessel H. ought to be of such description as to stand heating, as warming greatly promotes the electri current.

If several articles are to be galvanized at the same time, they same must be suspended so as not to touch each other, and if the battery is well united and prepared as we proposed, the articles will show in less than a minute a nice gilding, but it would be advisable to take them out from the solution and give them an alternate cleaning with cream of tartar as by this means the color will be heightened and the time of the operation shortened.

We are now content with having given all preliminaries necessary to operate with success the apparatus and now offer the prescription of a good solution.

Two dwts. of fine gold are rolled out and then cut into small pieces; we then transfer them into a fire proof cup in which we have previously placed three fourths of an ounce nitric acid and let this boil for a little while, and then add two ounces of muriatic acid and let them boil together until the whole becomes of a purple color, then take it off the fire, and pour the contents into a glass vessel containing three ounces cyanide of potash (granulated) and the solution will in the space of ten minutes show a deep yellow color and is ready for use. This solution will gild wares made of copper, brass, silver, steel, iron, cast iron, bronze, zinc and tin in a very durable manner, and in regard to appearance be second to none.

We would also intimate that brass, bronze, and copper, ought first be galvanized with silver, and zinc cast iron, steel, iron and tin, with copper, as gold will stay better on a previous galvanic layer.

As a matter of course every article ought to have a clean polish and smooth surface, as on the contrary no galvanic operation will take place, or if it does very imperfectly, and such negligence would waste time and material.

The market often requires articles being of gold and silver (partly) such as cups, goblets, dishes pitchers, &c.

All these can be obtained at a very easy variation of the usual manner of proceeding.

If for instance a goblet of silver requires gilding inside we set our battery to work as usual, wind the wire coming from the zinc pole, round the *outside* of the goblet, fill the cavity of the goblet with gold solution as far as it is wanted to be gilded, and bring a strip of gold attached to the wire coming from the copper end and place it in the hollow of the goblet (as far as it is to be gilded) but avoiding contact with the border of the goblet.

If everything be so prepared the cavity will soon show a golden surface, which will fairly compete with any fire gilded cavity. A great promotion of the process will be a previous warming of the solution.

To effect frosted gilding the article must remain twice as long in the solution and when taken out it

must be dipped into boiling rain water and be dried in the air.

As a certain method to obtain frosted gilding the solution must be warmed to sixty degrees Cel. and the solution must not contain an abundance of cyanide. Should it happen that the first trial should result in an imperfect dim color, the article must be brightened by brushing with cream of tartar and then it will certainly show the desired dimness, any part of which can be polished to relieve the rest.

We conclude this chapter by recommending scrupulous cleanliness and frequent use of cream of tartar.

CHAPTER II.

To Silver by the cooperation of Combined Elements or Batteries.

The manner of proceeding is exactly the same as gilding with the exception of the silver strip annexed to the copper pole wire to act as anode.

The operation does not require as much time as gilding and the solution does not require to be warmed, as in all cases the article will soon appear covered with a beautiful silver which fully answers all the demands of the most critical public.

Steel, iron, cast iron, zinc, copper and tin must be first covered with copper.

The following preparation of silver we venture to recommend to the attention of our readers as many silver plating establishments use the same.

One ounce of silver is dissolved in three ounces of nitric acid over a moderate heat, to this solution is added a pint of clear water and then a spoonful of table salt thrown into the same precipitates the silver chloride, which will be found at the bottom in the shape of a mass of white flakes lying very compact.

The water and acids are poured away and the sed-

iment rinsed until the water shows a natural color. We then pour over the washed chloride a solution of one and a half ounces of cyanide of potash in one quart of rain water, which will cause the solution to become turbid, but it will soon clear up and is ready to be used.

If a very large article must be silvered which our solution does not fully cover, water may indiscriminately be added until the article is fairly covered.

A bright metallic surface of the article must be considered a "sine qua non."

When covered with a satisfactory silver coat, take the article out of solution, rinse it in rain water, and dry it in saw dust.

CHAPTER III.

Coppering by means of Combined Elements or Batteries.

This operation does not admit of any further details as it is done in exactly the same manner as described in the two previous chapters with the variation of a strip of copper attached to the positive pole (copper wire). The solution defined hereafter, we have selected from hosts of presciptions as the most useful and safest.

Coppering claims more time than any of the previous operations, and should iron be covered with very old rust, it will be necessary to clean it by the following process:

Wind a copper wire round the iron and fasten to the other end of the wire a piece of zinc of a corresponding size, dip it in a solution of one part nitric acid and thirty parts water and the crust will in about fifteen minutes be removed. The quality of a galvanic coating of copper may best be judged when we tell our readers, that a sheet of iron covered with galvanic copper was taken through fire, made red hot and then

handled with steel burnishes and without losing its copper or any part thereof.

Copper solution—One and a half ounces of sulphate of copper and half an ounce prussiate potash dissolved in one quart of boiling water, adding successively four ounces of granulated cyanide of potassium until this mixture gets a dark yellow color. It must be remarked that the whole process of mixing must be performed by continually stirring, to prevent any overboiling.

PART IV.

The Practical Use of Sulphate of Copper Batteries.

CHAPTER I.

As in course of time every invention comes to a certain degree of perfection, particularly when an invention is considered which carries successfully the age and for such we set down the wonderful effects of the electro galvanic agents in their several forms. If we come to examine the validity of the idea to convey a speech thousands of miles in a few minutes, we might safely say we live in an age of wonder; when we further consider that the same agent removes rocks, and destroys subteranean obstacles, we might as well call the entire principle a *factotum*.

In the foregoing chapters we took occasion to call the attention of our readers to certain galvanic batteries, which we thought proper to recommend and although we are most sincerely convinced that our recommendation will find its justification, we can, however, not omit to do justice to other galvanic mediums suitable for gilding, silvering, etc., particularly such as are manufactured in this great country.

As a good electro galvanic battery, we notice the

sulphate of copper battery manufactured by Messrs. Hall and Palmer, as standing foremost. This battery comes in substance to the same rank, than the same apparatus we described in illustration No. six with the important difference that the former is made of such material and in such style as to be at once useful and ornamental.

The kind reader might form a wrong opinion, that we, now nearly at the end of our book take seemingly part against our apparent pet battery, but such is, however, not the case, as we shall not endeavor to depreciate our favorite for the single reason that we are inclined to patronize home industry, but we feel ourselves called upon, to bespeak favorably the sulphate of copper battery which comes so near to battery No. 6, because the same has been put up for the market and might easier be bought than made by the operator himself. As there is no material difference in the principle only more practicability in its construction which latter reason speaks laudable enough for its adoption and therefore we do not hesitate to do justice in the interest of our reader. The self manufactured batteries are mostly lacking in precision, because they are chiefly made of such materials which are to be got easiest and in no case they do present a good looking shape, as on the other hand those galvanic batteries manufactured by the above mentioned firm deserve due praise, as they not only command a good exterior but are made of such materials as to vouch-

safe good results, and we have no doubt that our reader will concur with us as soon as he has conceived the description of their construction.

The single sulphate of copper battery consists of a double cylinder of copper with a bottom of the same metal, which answers the purpose both of a galvanic plate and of a receptacle to hold the exciting liquid. The space between the two cylinders is filled with a solution of sulphate of copper (blue vitriol). A movable cylinder of zinc, which is let down between the two cylinders when the battery is to be put in activity. The circumference of the zinc cylinder is of course intermediate in size, as well as in position, to the two copper cylinders and is made to rest upon the outer cylinder by means of three insulating supporters of wood or ivory, projecting from it outwardly. Thus it hangs suspended in the solution and presents its two opposite surfaces (to the inner and outer cylinder respectively,) to the action of the exciting liquid. A screw cup is connected with the zinc cylinder and another one with the copper cylinder (outer cylinder) the former of which acts as the negative conductor (pole) and the latter as the positive conductor (pole), or when the wires of both cups are united, according to the theory promulgated in this book, the galvanic current or the electricity produced by the action of this battery passes from one to the other.

No doubt an outline of such a battery would in a great

measure facilitate comprehension, but we regret as the limited space does not admit of an additional engraving, and we therefore confide in the quick conception of our reading public.

The irritating material to create electric life is a solution of sulphate of copper (common blue vitriol,) in water. To prepare this liquid a saturated solution of the blue vitriol in made and to this solution is then added so much more water. To make sure of this operation we would propose to dissolve four ounces of blue vitriol in a pint of water so that a half saturated solution contains two ounces of this salt to the pint, as the ordinary temperature of the atmosphere is capable of dissolving one-fourth of a pound of blue vitriol in one pint of water. If this solution is mixed with a little alcohol the permanency of the action is increased.

The galvanic current is produced by the following process: The zinc is oxidized by the oxygen of the water, the oxide in conjunction with the acid of the salt forms sulphate of zinc, which remains in the solution: while the oxide of copper which was previously combined with the acid, being set free, partly adheres to the surface of the zinc cylinder, or settles down at the bottom as a black powder and is partly reduced to metallic copper which is thrown on the surface of the copper cylinder or sinks down in little flakes. The transformation of the oxide to the metallic state takes place in this manner. The water of the solution furnishes oxygen to the zinc and thus facili-

tates the conjunction with the acid; while the hydrogen which is free now, again forms water with the oxygen of the oxide of copper with which it comes in contact, leaving the metal liberated. Hence but little gas is created during the action of a battery charged with sulphate of copper as the hydrogen which usually escapes is in this case mostly absorbed.

By the above defined process a greater intensity in proportion to the quantity of electricity is produced, than in Smee's battery, from the fact that the final decomposition falls on oxide of copper and not on water, which is separated into its elements with greater difficulty than the former. The power of a galvanic battery is equal, other conditions being the same, to the amount of corrosive force in the solution, minus the power of chemical affinity which has to be suppressed in the decomposition which necessarily attends the action.

The sulphate of copper battery deserves a preference to many other galvanic agents, as the handling of different acids might inconvenience in a great measure many practical mechanics, as this battery only requires one kind of salt, the vapor of which and the actual effects of the sulphate of copper do not endanger the health of the operator, as the blue vitriol is entirely neutral and can consequently not impair the color or texture of organic substances.

The coating of oxide of copper must in all cases be removed from the zinc when the action of the battery

is no longer wanted. A good brush with the aid of sufficient water readily cleans the surface of the zinc, as an accumulation of this oxide will in time become so hard, that a file must be used to remove this coating and of course lessens the substance of the zinc cylinder, while a careful washing after every operation will preserve the cylinder and its substance. The deposit of copper which accumulates below, must also be removed which is done much easier, as a good rinsing generally suffices.

The sulphate of copper battery will, when charged with good liquid, keep in good action for twenty or thirty minutes at a time. The zinc cylinder should always be taken out of the solution when the battery is not in action but the solution itself may be left there, as it has no chemical action upon the copper but rather tends to keeps its surface in good condition. When the solution shows no longer a blue color, it has lost all its copper and consequently its power, a case, which will occur after a certain period of using the same, and it would not be best to attempt the renewal of its efficiency by adding a fresh portion of the salt; it should be thrown away and fresh liquid be prepared under the foregoing directions.

When the battery is filled with a good saturated solution of blue vitriol, the zinc cylinder is suspended between the copper cylinder but so as to avoid contact, because a union of the copper and zinc might create a by action and by this means interrupt the

whole process. When all is so prepared, a well nealed copper wire is fixed to the screw cup of the outer (copper) cylinder and to the other end we attach a strip of gold (when gilding), and then we add another wire to the screw cup of the zinc cylinder to which we connect the article to be operated upon. The article is held now into the gold solution and is fairly covered by the same, although the opposite strip only dives half its size into the gold solution. The article is now left two minutes into the solution and then taken out to be cleaned and put back again and left until it shows the desired surface.

Two such batteries will suffice for gilding and one for silvering, and as a matter of course when more then one battery is used they must be connected properly always a zinc end to a copper end, and the last zinc cup forms the negative pole and the last copper cup the positive pole.

CHAPTER II.

The protected Sulphate of Copper Battery.

The above named battery consists, firstly, of a solid zinc rod with sufficient space to allow the saline or acid solution to surround it; secondly, of a porous cell with a bottom, which cell is inserted to separate the solutions which exite the zinc and copper, which in this battery are of two different species; and thirdly, of a copper cylinder likewise provided with a bottom to embrace porous cell, zinc rod and solutions. With the zinc rod a screw cup is connected to act as negative polé, and vith the copper cylinder another cup to serve as positive pole. It will be necessary to allow the porous cell after being used to soak in several waters before its being dried and set aside, otherwise the salts which are contained in it will crystalize in the interstices and disintegrate its substance.

Having now described the construction of this battery, we will in the same time explain why a porous cell forms the only difference between this and the single sulphate of copper battery; a difference which

presents a very important feature and might be safely called a great improvement.

In the foregoing chapter we stated, when we defined the action producing electricity, that the zinc soon became coated with oxide or pulverulent metallic copper, after which the action of the battery declines. Now the efficiency of sulphate and copper furnishing oxide of copper to undergo decomposition in place of water is equally considerable in the final result when it forms only that part of the solution next to the copper cylinder. Therefore the interposition of a porous cell (unglazed earthenware), between the zinc and copper; two cells are provided, the outer one of which may be filled with a solution of sulphate of copper, while the inner one holds a solution of Glauber's salt (sulphate of soda,) or even common cooking salt. By this provision the zinc does not become coated by the oxide of copper, though sufficient of the copper solution impregnates the salt solution so as to necessitate an occasional cleaning of the zinc plate.

To raise the galvanic power of this battery, dilute sulphuric acid may be used to fill the porous cell, but in this case the zinc must be amalgamated with quicksilver, as otherwise the corrosive nature of the acid might soon consume the zinc rod. Another good idea which gives additional credit to the manufacturer is the provision of a lip to the outer cell (copper cylinder), which is used to add fresh crystals

of sulphate of copper to reanimate the solution when it has partly lost its strength.

The manner of using the protected sulphate of copper battery for gilding, silvering, etc , being exactly the same than the single sulphate of copper battery we will therefore not intrude any longer upon the patience of the reader and shall now proceed to the third chapter.

CHAPTER III.

The Combined protected Sulphate of Copper Battery.

This apparatus is the product of a later period and shows material improvements, as for shape and power, and is in our impartial opinion by far the best of the two already mentioned.

This instrument presents, in its vertical section, two copper cylinders like the single sulphate of copper battery, between which the zinc cylinder enveloped in a porous cell made of leather is placed. The main difference is apparent by the plan of using two copper cylinders forming one solid piece, and a zinc plate enveloped in a leather cell. The inventor probably labored under the impression that porous cells of earthenware are of too fragile a nature and could, when the battery is very capacious, not easily be obtained and therefore suggested this alteration, an idea which we cheerfully share with him.

According to the principle of this battery, both surfaces of the zinc are opposed to the corresponding surfaces of the copper cylinders. Other membranous or porous substances, such as thick brown paper or bladder, might answer the same purpose in preventing the

ready admixture of the solutions and allowing a free passage to the electrical current, but the insertion of a ready made leather bag comes handier, as the same is made of such material to vouchsafe durability, which quality would seem problematical by the use of paper or leather.

The action within this class of battery is as follows: The zinc is oxidized as usual by the water of the solution surrounding it, while the hydrogen, instead of being given off at the surface of the negative plate, as in most batteries, decomposes the sulphate of copper, forming water with oxygen of the oxide of copper and setting free the sulphuric acid which passes through the porous partition iuto the other cell. A gradual and steady supply of acid is thus furnished to dissolve the constantly forming of oxide of zinc.

The combined sulphate of copper battery is a constant chain, from the fact that it will maintain a nearly unvarying power for several days in succession, if the solution of sulphate of copper is kept well concentrated by occasionally adding small portions of the pulverized salt and stirring the liquid to make it of uniform strength. With weaker solutions or a less permeable partition, an action of sufficient energy for many purposes may be sustained for a week or more; when it declines it may be renewed by cleaning the zinc plate and removing any loose deposit from the cells. This constancy of action renders this battery of great value, in the electrotyping pro-

cess, which process, however, does not come within our limits. The deposition of metallic copper on the negative plate is the principal inconvenience attending it; this deposit sometimes adheres so firmly as to be difficult of removal, which, however, is only necessary when it interferes mechanically with working of the battery.

The method of working this battery is exactly the same than all the foregoing, and need no further commend as to rules of proceedings.

CHAPTER IV.

Up to this time we described batteries composed of copper and zinc in their various and different styles, and now we take occasion to delineate such galvanic elements which entirely differ from any of those already spoken of. It has been the original idea that a galvanic column must consist necessarily of zinc and copper to create electricity, but this theory has likewise been overthrown, as we shall show by the construction of

Grove's Battery.

This battery consists of zinc and platinum, and is, according to the testimony of thousands, the most powerful in existence. The metal platinum used in this case, as it is the least oxidizable of the metals and therefore capable of producing a more powerful current with zinc than any other. The sulphate of copper batteries which have been spoken of, have been sometimes called *hydrogen-consuming* batteries, because they provide a chemical agent, oxide of copper, with which the hydrogen produced in the first instance by the decomposition of water unites to form water again, thus separating copper from its oxide in the

metallic form. The only chemical affinity which has to be overcome, in *this* battery, is that of oxygen of copper. Its force may be stated as equal to the affinity of oxygen for zinc, minus the affinity of oxygen for copper.

In Grove's battery, which we are going to describe, another important step towards perfection has been made, and the advantage deriving therefrom fully gained. The electro-negative metal, as in Smee's, is platinum, which, from the condensed form of the battery, can be used without too great expense. Instead of sulphate of copper, strong nitric acid is employed for the purpose of furnishing oxygen to the hydrogen, with the following advantage: nitric acid consists of five equivalents of oxygen and one of nitrogen. The fifth equivalent of oxygen is held by a very slight affinity, many chemical agents sufficing to reduce the nitric acid to nitrous acid, which has one equivalent less. The increase of power in Grove's battery over the sulphate of copper battery, for the same amount of of zinc dissolved, is equal to the difference of affinity between oxygen for nitrous acid and oxygen of copper. The power of Grove's battery is, therefore, equal to the affinity of oxygen for zinc, minus the affinity of oxygen for nitrous acid.

It must also be considered that the energy of an electro galvanic arrangement depends, to some extent, upon the difference in the affinity for oxygen of the metals employed, which, in the case of platinum and

zinc, is at a maximum. The zinc plates must necessarily be amalgamated to guard them against corrosion. The battery is worked by two fluids; the one within the porous cell and in contact with the platinum being strong nitric acid, and the other, which surrounds the zinc, being sulphuric acid (oil of vitriol) diluted with ten or twelve parts of water. That this battery, in consideration of its small compass, is the most energetic in existence, we substantiate by the fact that this battery, exposing twenty square inches, was found, by its magnetizing power, to afford an electrical current of greater quantity than a sulphate of copper battery exposing two hundred and ten square inches of zinc. The intensity of the current in Grove's battery is also considered three times as strong as in the latter and probably four times as great as in Smee's. The same platinum and zinc of a Grove's battery being used as a Smee's (both metals under the attack of dilute sulphuric acid), gave less than a fifth of the current in magnetizing power. Grove's battery is also exceedingly constant and will, when the same is composed of four pairs, absorb an ounce of gold in cyanide in twenty-four hours.

The disadvantages arising by the use of this battery are, first, the strength of the acids which are employed making it disagreeable and unsafe to a careless experimenter; and, secondly, the red fumes of nitrous acid which it gives off abundantly while in action. These are irreparable and injurious to a nice apparatus which

may be exposed to them. By placing a metallic covering (protected from the acid fumes) over the battery, and allowing the gases to escape through an orifice stuffed with cotton, wet with a little alcohol, this may be, to some extent, neutralized.

It should always be remarked that the quantity of electricity produced is, in all these batteries, proportionate to the quantity of zinc dissolved, and where a small surface of zinc gives a large current it is acted upon with greater rigidity. The intensity of the current produced in these forms depends upon the chemical affinities which are concerned; and on this account there is a gain in the sulphate of copper battery over Smee's and a still greater in Grove's.

Having now sufficiently explained the advantages of this battery, we proceed now to define its construction. The containing vessel is glass about four inches high; within this a thick cylinder of amalgamated zinc standing on short legs and divided by a longitudinal opening on one side, in order to allow the acid to circulate freely. Inside of the zinc cylinder is a porous cell of unglazed porcelain, containing the nitric acid and a strip of platinum. The platinum is supported by a strip of brass, fixed by a thumb-screw and an insulating piece of ivory, to the arm projecting from the zinc cylinder. The amalgamated zinc is not acted upon by the dilute sulphuric acid until the circuit of the battery is complete, but a small portion of the nitric acid filters through the porous cell, by which

the zinc would be readily attacked. It is, therefore, advisable to remove it from the acid when the battery is out of action for any length of time. A series of twelve pairs of Grove's batteries is of very considerable importance, and is now extensively used for purposes requiring a constant galvanic current of great quantity and intensity. In this compound battery each strip of platinum, except the terminal one, is soldered directly to the arm projecting from the adjoining zinc plate. The terminal strip, with its screw-cup, is supported by the first zinc plate, but is insulated from it. This galvanic agent is in almost all cases resorted to for the magnetic telegraph. For chemical and illustrative experiments requiring a current of great power, this has now, to a considerable extent, superseded the older form of consecutive plates. It was stated that Grove's battery may be considered as having three times the intensity of the sulphate and copper battery. A series of twelve pairs, therefore, would be as powerful as thirty-six pairs of the latter, and more so than the same number of pairs in which only sulphuric acid is employed.

We trust we have given a complete outline of Grove's battery together with its action and decomposing power, and beg now to inform our reader how to use it practically.

For gilding, we propose two of Grove's batteries as sufficient in most cases, and how they are to be connected, we shall further show now. We fill into the

two glasses one half ounce of sulphuric acid and about four ounces of water, which raises this liquid to about three-fourths of the size of the glass itself, and the same is getting gradually warmer, as the water and acid decompose each other; then we place the zinc cylinder into this solution and let it rest for about two minutes, and then we pour upon the border of the cylinder eight ounces of quicksilver and pour the liquid with the quicksilver off and place the cylinder in another empty glass, and repeat the manipulations so often until the zinc shows a perfect silver covering, and is then to be considered as proof against corrosion. With the second cylinder we do the same. When both cylinders are so amalgamated, they are placed into the two glasses holding the aforesaid solution of sulphuric acid and water, but to such an extent as to fill the glasses half their size. Then we place into the cylindrical cavity of the cylinders two porous cells and fill them with strong nitric acid, but take care that these two acids do not flow freely into each other. When this is done, the platinum strip soldered to the arm of one of the cylinders is suspended into the porous cell of the zinc cylinder, which has to act as negative pole and has no platinum connection, and we fasten the insulated platinum strip connected with a screw-cup to the thumb-screw of cup being between the soldered platinum strip and the cylinder, so as to reach in the porous cells. All being so prepared the battery is ready for action, and to guide the current into the

solution we attach a well nealed copper wire to the cup of the insulated platinum strip, which here serves as the positive pole, and another well nealed wire, holding the article to be gilded, is attached to the screw-cup of zinc cylinder which only holds the porous cell, but no platinum. As soon as both wires are suspended into the respective solution a violent rising of bubbles round the negative wire will be perceptible and betokens the presence and action of the galvanic current.

For gold solution best adapted to the action of this battery, will be the following composition:

Dissolve a five dollar gold piece in nitro-muriatic acid (a mixture of one part nitric and four parts of muriatic acid), evaporating the salt very carefully, in order to drive off the excess of acid, and keep it over a slow heat until fully dry. This salt is then redissolved with a sufficiency of cyanide of potassium to clear the solution, it requiring three-fourths of an ounce of the cyanide for this purpose. Enough water is then added to make two quarts. As a general rule, it requires more battery power for gold than for silver, but two batteries combined as aforesaid will fully suffice. The addition of a small quantity of cyanide of potassium to a solution diminishes the tendency to black deposits, where this is exhibited and where the fault is referable to the solution. But when this fault is found, the cyanide is already mixed with the chloride of gold and can not be regained or reduced, and

therefore we advise the operator to add in small portions of chrystalized soda, which neutralizes the action of the cyanide to a certain extent, so as to prevent any farther black or dark deposits.

We take leave to repeat that it is absolutely necessary, that the surface on which a metal layer shall be deposited, should be perfectly clean and free from a film of air, that it may adhere, and the metal should be thrown down with sufficient energy to prevent any local action with the mould. The article to be gilded or silvered may in some cases be cleaned by a solution of potash; but the deposit is more certain to adhere if the surface is rubbed with a little rottenstone, when first placed in the metallic solution, and connected with the battery. Whenever, during the process the deposit becomes discolored or rough, the negative plate should be taken out and brushed with a little whiting and water. The thickness of the coating of gold and silver is proportional to the time occupied by the deposition and the amount of electricity which passes.

For the same amount of electricity, thirty-two grains of copper, one hundred and eight grains of silver and ninety-nine grains of gold are deposited, these being the chemical equivalents of those metals.

The salt of silver calculated for decomposition through the action of this battery is the ferrocyanide. A silver dollar is dissolved in one ounce of nitric acid and the silver then precipitated in the state of chloride

by muriatic acid or common salt. The precipitate is washed and then added to a sufficient quantity of a hot saturated solution of ferrocyanide of potassium (yellow prussiate of potash) to dissolve it. Sufficient water is then added to make two quarts. The solution may be poured off from the sediment which remains or it may be used at once. It must be remembered that the salt employed contains cyanogen, the active principle of prussic acid. Prussic acid itself and oxygen are evolved at the positive pole during the decomposition.

A solution of cyanide of silver may also be used, which is obtained, by dissolving the precipitate of chloride of silver, mentioned above in cyanide of potassium instead of ferrocyanide; in this case the solution of cyanide of potassium need not be so strong or be raised above the common temperature. Only sufficient of the cyanide of potassium need be added to take up all the chloride of silver.

CHAPTER V.

To conclude the series of our different batteries we can not omit to mention finally the construction and action of

Smee's battery.

to complete the number of batteries used for gilding, silvering, etc.

Although we have subjected this battery to several trials, we can not but praise its excellent action, but do, however not *urge* its adoption. This apparatus offers one convenience, that owing to its principle only one exciting fluid is necessary to create a galvanic constant current, which is very well adapted for all other purposes, except producing a nice, good golden color. Also the use of such a battery exhausts the solution, as, instead of a strip of gold, a foil of platinum is used as anode, which metal does not dissolve under the action of a galvanic battery, when used as positive pole. For electro-etching and electrotyping (copying seals, moulds, daguerreotypes, etc.) a better instrument could not be found.

The Smee's battery consists of a glass tumbler or other receiving vessel, on which a little frame rests, supporting the apparatus within. The metals employed are platinum and zinc. The original battery

of Smee consisted of zinc, and silver covered with a film of platinum; but the metal platinum itself is found so much superior to the platinized silver and the difference in the expense so slight that it has been substituted. The metal platinum is used in this case, as it is the least oxidizable of the metals, and therefore capable of producing a more powerful current with zinc than any other. On the frame two screw cups are inserted for the attachment of wires by which the current may be conveyed in any direction. One of these screw cups communicates with a strip of platinum foil, which is suspended between two zinc plates, both of the surfaces of the platinum being opposed to the zinc. The amount of galvanic action is generally in proportion to the metallic surfaces of different kinds to each other, and also in proportion to the nearness of these surfaces. The other screw cups is connected with both the zinc plates, thus uniting them into a single element of the pair.

The screw cup connected with the platinum is insulated from the metallic frame which supports it, by rosewood; and a thumb screw seen at the left, confines or releases the zinc plates, so that they can be renewed from time to time.

The liquid used to excite the battery is sulphuric acid (oil of vitriol), diluted with ten or twelve parts of water by measure. This acid acts on common zinc when the galvanic circuit is not established, and a great loss would therefore ensue from corrosion of

the plates during the interval of experiments, even if the zinc was withdrawn from the acid whenever practicable. To remedy this defect, it has been found that zinc, which has its surface amalgamated (or covered with mercury), withstands the action of dilute sulphuric acid, unless it is in galvanic connection with another metal; and accordingly the zinc of this battery and of other batteries in which acid is used, is commonly amalgamated. It then remains almost uncorroded until the galvanic circuit is completed by making contact between the wires, when the zinc is immediately attacked. The amalgamation of the zinc is easily effected by rubbing it with a little murcury and muriatic acid at the same time. This battery when once in action is very constant. It does not, however, like the batteries of Grove and others, arrive instantly at its highest rate of action when the circuit is completed, but takes an appreciable time to reach this point, and it is not therefore fitted for use with apparatus where the circuit is rapidly broken and renewed. No adequate increase of power is obtained by adding to the size of this battery.

In order to understand some of the phenomena which are to be spoken of hereafter, it is necessary to notice what takes place when the circuit is completed and the galvanic current begins to flow. The first thing which is observed is a rapid evolution of gas in bubbles from the platinum plate. It was stated electricity was supposed to pass through the liquid between the plates in a direction from the zinc to the

copper or platinum. This passage of electricity through fluids, which are not themselves elementary, is attended always, according to Farraday, with decomposition, whether the fluid is between the plates of the battery or interposed in the course of the wires or poles leading from it. Thus, where a battery is excited simply by water, that fluid is decomposed; its oxygen attacks the zinc, and its hydrogen is given off in contact with the electro-negative metal.

In Smee's battery, the water of the acid solution may also be considered as undergoing decomposition, one atom of its oxygen uniting with one atom of zinc, in order to enable the sulphuric acid to unite with the resulting oxide of zinc, and the corresponding atom of hydrogen being given off in contact with the platinum. It will be observed that the oxygen and hydrogen appear at the opposite sides of the fluids undergoing decomposition. It is not, however, believed that these elements travel through the intervening distance, but that the two atoms of water in contact with the plates are simultaneously decomposed, and that a chemical equilibrium is then established by a progressive exchange of elements in all the intervening particles. The subject of electro-decomposition has already been spoken of and does not require further definition.

The gas which is so plentifully disengaged at the surface of the platinum in this battery is apt to bring the strip into contact with the zinc, and thus cause a

discharge between the metals within the battery instead of through the poles without. To obviate this, the platinum is either confined in its proper position by some fixture at the bottom, or a head of glass is attached to it, which prevents its swinging against the zinc.

Another form of Smee's battery is the so called "Odds and Ends," a new and improved variety. In this battery a new principle is introduced, as the inventor proposes the deposition of a small portion of mercury at the bottom of the glass vessel containing the odds and ends. A platinum plate is suspended in the centre, beneath one of the screw-cups. One or more zinc plates rest against the sides of the vessel, not being held any where, and are in contact with the mercury below. A curved wire descends through the liquid, insulated by a glass tube, to the mercury, which it connects, in common with zinc, with the plate on the top and the other screw-cup. This battery will operate if single scraps of zinc are placed in the mercury. The mould in the depositing cell is connected with the zinc or negative pole of the battery.

During the dissolution of the positive plate, a considerable quantity of black matter is left, most carbon, which would injure the copy (in case electrotyping is just done) if allowed to fall on the mould. It is, therefore, best to place both in a vertical position, the face of the mould being opposite the piece of copper. The solution must be stirred occasionally, to keep its upper and lower parts of equal strength.

When the process is going on well, the deposited metal will be of a very light copper color. The rapidity of the deposition depends greatly upon the temperature; the process proceeds much faster in warm weather than in cold, and much more so, if the solution be kept hot. A thickness of a tenth of an inch may require from three days to a week for its formation, when artificial heat is not used. When a sufficent thickness has been attained, the cups may generally be removed from the mould without difficulty; care being taken to cut away any copper which embraces the mould at the edges.

The odds and ends are most used to fell copper, to copy moulds, and therefore every ounce of copper deposited requires the solution of somewhat more than an ounce of zinc from the zinc plate of the battery. Five or six electrotypes may be made at once, without increasing the expense, by arranging in succession several vessels each containing a mould and a copper plate connected by a wire with the mould in the next one.

The odds and ends used for gilding and silvering consist of from three to six or eight pairs, according to the extent of surface to be covered and the resistance offered by the solution. As the solutions grow older they require less power to decompose them; but there is then a greater tendency to black deposits. The positive pole usually employed is a platinum wire or pointed strip of platinum foil. This metal defies the

action of galvanic decomposition, and consequently the electro-negative element of the salt has to be evolved, instead of entering into a new combination. It is on this account that several pairs have no more efficiency in decomposing the solution than one pair, where the positive pole is soluble. The arrangement of three pairs is to bring the whole action more exclusively under the control of the battery and to avoid local contact. For ordinary purposes, Smee's battery weakly charged, is in a great measure preferable, because a constant and steady current is prevailing.

Another variation in the odds and ends is a protecting cover to prevent the escape of hydrogen and guarding against inhalation of the acidulated vapors and fumes.

Another form of Smee's batteries for silvering is to remove the porous cell of Grove's battery. The platinum plates are attached to little arches of wire, which enter small holes in the zinc, into which they may be wedged or from which they may be removed at pleasure. Opposed to the article to be silvered we place a piece of silver foil connected with a wire to the positive (platinum) pole, which is dissolved in proportion as silver is deposited on the article. A very pure coating of silver is thus given to the article and the solution kept on the same scale of concentration.

A series of such batteries in the reformed shape is used to effect the deposition of alloys by the galvanic

current. If two metals are contained in a solution, the general law is, that the one most easily reduced by the electrical process will be deposited first and in a state almost absolutely pure. If the energy of the current, however, is very much increased, all the metals present will go down in variable proportion. Thus, if there is a little silver in the gold solution, a feeble current will throw down the silver first; if there is copper present, and no silver, a feeble current will throw down a pure yellow deposit of gold, while a stronger one will throw down a reddish metal resembling the gold of jewelers and of the mint.

We think now of having described the most prominent features of the different forms of Smee's and other batteries, as far as they come within the limits of electro gilding, silvering and coppering and beg now to say before concluding the series of accounts relative to combined batteries, that we would advise every one of our readers who should desire to try either of our foregoing galvanic batteries, not to trust *too much* to those which he has to manufacture himself, and rather patronize manufacturers who warrant their goods.

CHAPTER VI.

Coloring of Gold.

(Galvanic Alloy.)

The refined taste of the public made a variety of colors requisite, as for instance, the high golden color of Filigree would hardly be applicable to solid articles (watch cases for instance) nor would the color of chains if applied to rings or table sets be in compliance with the demands of the market.

In order to obtain a certain alloy to a gilded surface we have devoted a good portion of time to this desirable object, and how far we have succeeded we submit to the decision of the kind reader.

For this purpose we have made gold, silver and copper solutions all of which contained a surplus of cyanide with doubly the quantity of water we usually administer.

We took to half a pint of gold solution one-eighth of a pint of copper solution and found the deposit of gold equal to twenty-four carats standard or reddish yellow suitable for Filigree work, and an addition of one-eighth of a pint copper solution produced a good eighteen carats color still slightly reddish yellow.

A mixture of half a pint gold, one-eighth silver and one-sixteenth of a pint copper produced a sixteen carats color but greenish yellow and the composition of half a pint gold and one-fourth pint silver (copper entirely omitted) showed a fourteen carats color, rather white yellow. This is one way to alloy by mixing solutions.

Another method to effect a different color would be to add to two dwts. fine gold, six grains pure copper (best dial copper) at the dissolution, this composition raises the gold to the highest color for fancy gilding; an addition of so much pure silver dissolved with the gold will bring the color of California gold (slightly green).

APPENDIX.

To Regain the Gold or Silver from Solutions.

We were often struck with the idea how to regain our previously dissolved metals and are happy to say that we can conclude our book by instructing our patrons by two well tried methods to accomplish this object.

We added muriatic acid in small portions to a silver solution until all silver chloride was precipitated and a violent rising of prussic acid was produced until this solution has discharged all its metallic contents, and it would be advisable to perform this operation either under the open sky or in a room where a good current of air is prevailing.

The liquid must be stirred to facilitate the precipitation and the operator should take good care not to hold his face too close to the vessel as the evaporation of the prussic acid might produce very injurious consequences.

As soon as the silver has been felled, the same must be filtered, dried and reduced to silver in a crucible, glazed with borax and potash.

This is one method of recovery, but another offering less inconvenience is the following:

All the liquid of the gold or silver solution is evaporated over a moderate fire and the dry remnants are now molten in a crucible adding saltpetre in small quantities to reduce the prevailing cyanide into carbonate of soda, and saltpetre must be added as long as foaming is perciptible.

This substance when entirely cold must be washed to free it of its acidulated coat, and shows then the regulus of the gold or silver or the finest parts of those metals in a solid piece, fully qualified to serve as material for the finest work.

The last and best method we are going to offer now:

We term it therefore the best method as no danger is to be incurred, no melting or refining is necessary and our gold and silver comes back without losing a particle of the same, a case which can not be avoided by the other process. We therefore propose a galvanic operation and warrant the issue.

We simply take our battery, fix to the zinc end a piece of gold and to the copper end a piece of platina, (a metal which does not dissolve by the action of the cyanide) and by this means every particle of gold will be deposited upon the gold piece and consequently augment its weight; when the rising of bubbles has ceased the solution has discharged all its metallic contents. We provide, however, that the elements were in working order then an interruption

of electricity and consequently the cessation of the rising bubbles may derive from inefficient stimulating material such as used up vitriol and copper, and turbid salt water.

A dwt. of gold was dissolved under our direction and transferred into a solution.

We suspended a silver strip weighing six dwts. to the zinc pole (negative pole), and in about seventy-two minutes the electric life seemed extinct, and the elements yet in good order.

We weighed this strip and found it to weigh six dwts. and twenty-three grains; the balance must have been lost by evaporating the acids.

A further striking proof in favor of our proposition is the following experiment:

We rolled the above silver strip out in four pieces and boiled them in nitric acid as soon as all silver was dissolved from the gold; we weighed our gold strips and found them to weigh twenty-three grains.

We brought these strips under the hammer and beat them out like gold leaves, and finding in them all the qualities of fine gold.

We therefore conclude this chapter by intimating to the reader, that the galvanic agent has every qualification to substitute fairly the old school practice of fire plating, and the galvanic gilder has the great advantage of producing a good galvanic plate of a better appearance than the fireplater at a saving of at least five hundred per cent, and he can deposit his

gold in such places as the fireplater can not reach. He can not lose any of the precious metal, as we have provided the means of recovering the same, an advantage TOTALLY lost to the fireplater.

And, finally, his health is safe, while the fireplater falls the victim of the very injurious vapors of the quicksilver.

In case the operator should feel inclined to regain the gold or silver already deposited upon goods, we propose a very simple way of accomplishing that purpose; we fasten the already galvanized goods to the copper pole end wire (positive pole) and the gold or silver strip to the zinc pole end wire (negative pole), and in a very few minutes the gold or silver so intimately connected with the goods will be found transferred to the gold or silver strip, after which operation the goods will show their original metal.

CONCLUSION.

We have endeavored to be as explicit as possible, to guard our readers, who should be willing to follow our methods, aganst any kind of misshape.

But it must be admitted that every chemical operation, if ever so clearly demonstrated, will show some slight deviation in the course of operation.

Therefore, we deem ourselves justified in recapitulating the most indispensable rules of proceeding.

Firstly—Clean the articles to be galvanized most scrupulously.

Secondly—Fasten the articles to be galvanized tight to the zinc pole end and take good care that the conducting wires are bright.

Thirdly—When the first golden or silver hue is perceptible take the article out and clean it.

Fourthly—Should the article show a black or brown color take it immediately out and clean it.

Fifthly—Prevent any contact between the anode and kathode, and

Sixthly—Work always with wet fingers and clean water, as cleanliness of the article and cleanliness of the fingers will certainly contribute towards a desired result.

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